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A Supervised Machine Learning Approach to Identification of Risk Factors for Spinal Cord Stimulator Explantation

Peyton Murin, Patrick Murin, Yuri Chaves-Martins
SSM Health/Saint Louis University

Introduction

Spinal cord stimulators (SCS) have shown efficacy in the treatment of both pain (1) and urinary dysfunction (2). However, given the high costs of the device, it is increasingly important to identify patients at high risk of explantation (3). Despite previous attempts to establish guidelines (4), factors predictive of adverse outcomes in after SCS implants remain mostly unknown (3). Here, we sought to apply supervised machine learning in the form of a multivariate logistic regression to identify risk factors for SCS explantation.

Materials and Methods

As research utilized a publicly available database, it is exempt from review per Saint Louis University IRB policy.

The MOVER database (5) was queried for patients undergoing spinal cord stimulator placement between 2017 and 2022 with or without explantation. After removing duplicates, 118 unique patients (62 – lumbar/thoracic, 56- sacral) were identified and demographic, clinical, and medical history data was compiled. Early device explantation was defined as device removal for any cause in the first 2 years after implant. Fisher's exact test was used to compare demographic and medical history data. Then, data was imported into Anaconda (Anaconda Software Distribution, Austin, TX) with the following add ons used for analysis: pandas, numpy, sklearn, sklearn extra, matlab (The MathWorks, Inc., Natick, MA), and seaborn. The data was scaled and the classes were balanced. The data was split into training and testing, with performance assessed using precision, recall, f-score, and area under the curve. Once performance was deemed satisfactory, the model was used to calculate odds ratios and confidence intervals for each assessed variable. Using this same protocol, subgroup analysis was done with thoracic/lumbar and sacral SCS subgroups, respectively.

Results/Case Report

The cohort was on average 62.1 years (SD 14.9) old and 72% female, with the most common indications for SCS implant being urinary dysfunction (52.4%) and low back pain (42.4%). Gender, anesthesia type, an indication of low back pain or urinary dysfunction, and medical history of malignancy differed between the patients with explantation (n = 54) and those without explanation (n = 64). (Table 1)

The logistic regression model displayed robust performance (precision: 0.83, recall: 0.71, F1-Score: 0.77, AUC: 0.84). The highest risk factors for explantation overall were history of sleep disorder (OR: 3.34, CI: 3.28-3.41),

malignancy (OR: 2.45, CI: 2.43-2.48), chronic kidney disease (OR: 1.94, CI: 1.91-1.98), length of stay (OR: 1.85, CI: 1.83-1.87), and urinary dysfunction (OR: 1.81, CI: 1.79-1.84). (Figure 1).

Amongst thoracic/lumbar SCS patients, the highest risk factors were obesity (OR: 2.42, CI: 2.38-2.46), length of stay (OR: 2.12, CI: 2.06-2.22), and history of sleep disorders (OR: 1.91, CI: 1.55-2.35), while for sacral SCS patients the highest risk factors were history of malignancy (OR: 3.41, CI: 3.30-3.52), arthritis (OR: 3.38, CI: 3.29-3.46), and American Society of Anesthesiologist (ASA) score (OR: 2.83, CI: 2.79-2.88).

Discussion

Given the rising costs of SCS, it is increasingly important to identify patients at risk of explantation prior to placement. Using a machine-learning-based approach, we were able to identify several medical comorbidities predictive of explantation, emphasizing the need for a robust medical history in the pre-operative evaluation of SCS.

References

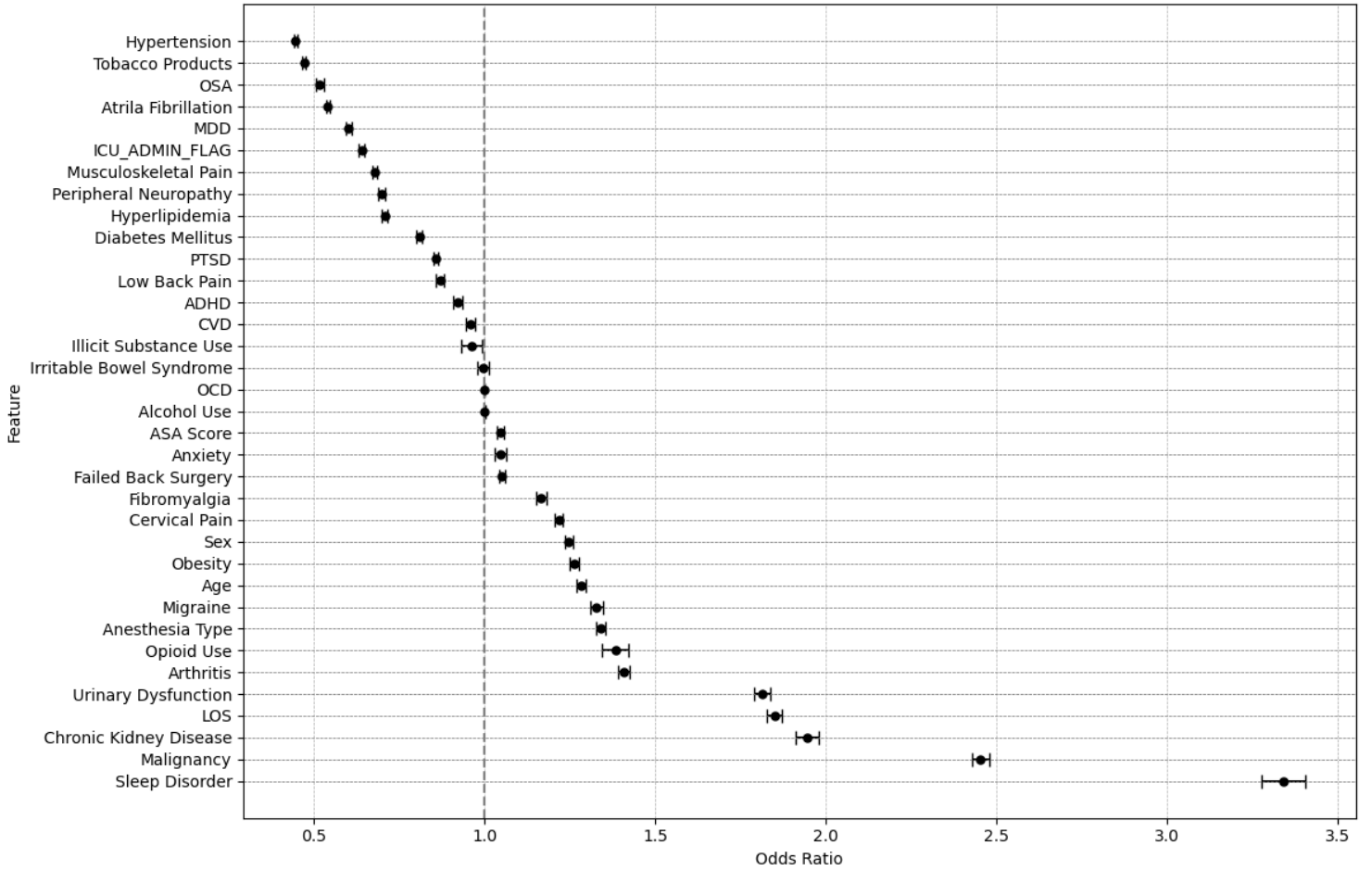
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Disclosures

No

Tables / Images

Forest Plot of Odds Ratios with 95% Confidence Intervals



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